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The Role of Nonspecific Effort Dynamics and Zoning in Performance Prediction in the Water Polo Game

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Abstract

Water polo is one of the sports where acyclic movements are predominant. The latest modifications made to the rules of the game have determined an increase in the speed and complexity of the attack and defense phases. The breakdown of the dominant energy systems in the water polo game is the following: alactacid 10%, lactacid 30%, aerobic 60%, and the performance limiting factors are represented by acceleration power, throwing power and the like, all these relying on a solid aerobic basis.

Key-words: effort dynamics/zoning, Polar S625X Running Computer, HR, VAM.

1. Conceptual delimitations and purpose of the research

Effort capacity does not represent a sum of the functional capacities of all the organs and systems of the human body. Dragnea, quoted by Cordun, in 2011, asserts that it is "limited by those organs which, after they reached their maximal functional capacity, hinder the continuation of the effort, although other organs and systems would still allow it". A progress factor was represented by the identification of the organs and systems limiting the effort capacity. To exemplify, Klisuras (1986), quoted by Bota, 1993; Maglischo, (1993, 2003) states that VO_2max is genetically determined in a proportion of 93%. We use this example because the purpose of our research is to prove that, by knowing the metabolic cost of nonspecific training (on dry land), we can make predictions about the body's response to specific effort (in the water) and, implicitly, about the performance that can be achieved. Holmer and Astrand (1963; 1974) quoted by Maglischo, (2003) found that, in swimmers, VO_2max was 6-7% lower when they were tested in the water than when they performed the running test. We used running, as a means to test their effort capacity, because the lower limb muscles consume 80% out of the VO_2max in the water.

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1.1. Hypothesis of the research

By knowing more about effort dynamics and metabolic cost on dry land, water polo coaches are provided with information about the athletes' expression level in specific competitions.

1.2. Methods of research

The present paper represents a pedagogic constative experiment, in which we used the following methods of research: test method, graphical method (of the Polar S625X Running Computer) and statistical-mathematical method, with the statistical parameters of the central tendency - arithmetical mean (X), the statistical parameters of dispersion - standard deviation (S), the coefficient of variability (Cv) and Pearson's coefficient of correlation (r) - a parametric statistical test for quantitative data (Popa, 2008).

2. Design of the research

2.1. Period, location and subjects of the research

The experiment included the members of two water polo clubs in Bucharest, competing in the National Championship: one ranked 1st (Steaua School Sports Club 3) and the other ranked 2nd (Emil Racoviţă Sports College). We tested the athletes born in 1997, 11 from each team, who played in every match with their club teams. The tests were administered for the players belonging to the Emil Racoviţă Sports College on 11.04.2012 (5-minute endurance running) and 25.04.2012 (VAM endurance test), at the Tineretului (Iolanda Balas Soter) stadium. For the players from the Steaua School Sports Club 3, tests were organized on 11.04.2012 (5-minute endurance running) and 27.04.2012 (VAM endurance test), at the stadium within the Izvorani Sports Complex.

2.2. Administered tests

- The 5-minute endurance running test consists of running at a constant speed. The subject must cover a distance as long as possible. At the end of the 5-minute running, the distance covered is recorded;
- The VAM-eval endurance test (maximal aerobic speed), also called the 20-m shuttle test, consists of running at a progressively increasing speed. During the entire duration of the event, a special cassette indicates by beep sounds the running pace for the 20 levels or portions, the speed being gradually increased. The test is interrupted when the subject fails to keep the running pace imposed, the difference between the sound signal and the distance to the cone being greater or equal to 2 meters; we note the level reached that indicates the speed value, which allows us to estimate the relative VO_2max (ml/min/kg).

2.3. Presentation, analysis and interpretation of the results

In Table 1 we present the results obtained following the administration of the two nonspecific tests ((test I = 5-minute endurance running with the VAM value and test II = endurance test, portions, with the VAM value).

Table 1. Results obtained after the two tests

	Emil Racoviţă Sports Club					Steaua School Sports Club 3				
No.	Surname and name	Test I m.	VAM Km/h	Test II Portions	VAM Km/h	Surname and name	Test I m.	VAM Km/h	Test II Portions	VAM Km/h
1.	T.I.	1140	13.6	P 8 / 15 s	12.1	M.C.	1210	14.5	P 9 / 45 s	12.9

2.	V.A.	850	10.2	P 5 / 15 s	10.6	I.R.	1175	14.1	P 8 / 30 s	12.3
3.	N.D.	1120	13.4	P 8 / 45 s	12.4	S.T.	1350	16.2	P 10 / 15 s	13.1
4.	M.C.	1200	14.4	P 7 / 15 s	11.6	B.P.	1000	12	P 7 / 30 s	11.8
5.	J.N.	980	11.7	P 7 / 15 s	11.6	C.M.	1150	13.8	P 7 / 30 s	11.8
6.	L.A.	1200	14.4	P 7 / 15 s	11.6	B.A.	1300	15.6	P 10	13
7.	G.V.	1000	12	P 5 / 15 s	10.6	D.C.	1250	15	P 9 / 45 s	12.9
8.	V.A.	1090	13.1	P 7	11.5	T.P.	1150	13.8	P 8	12
9.	G.R.	850	10.2	P 5 / 15 s	10.6	B.A.	1250	15	P 8 / 45 s	12.4
10.	C.D.	1200	14.4	P 9 / 15 s	12.6	C.G.	1000	12	P 7	11.5
11.	Z.I.	1250	15	P 7 / 45 s	11.9	B.L.	1100	13.2	P 8 / 30 s	12.3

Table 2. Statistical processing of the results obtained

	Test I Meters			Test I VAM, Km/h			Test II Portions			Test II VAM, Km/h		
	X	S	CV	X	S	CV	X	S	CV	X	S	CV
Racoviţă	1080	141.2	13.07%	12.9	1.69	13.1%	P 7	P 1 / 15 s	17.85%	11.5	0.7	6.08%
Steaua	1175	112.6	9.58%	14.1	1.35	9.57%	P 8 / 30 s	P 1	11.76%	12.3	0.55	4.47%
DIFF	95	28.6	3.49%	1.2	0.34	3.53%	P 1 / 30 s	15 s	6.9%	0.8	0.15	1.61%
Pearson's coefficient of correlation between the two tests												
Racoviţă							r = 0.778					
Steaua							r = 0.884					

- Data analysis and interpretation – test 1 (5-minute endurance running – Table 2)

The mean of the distance run within the 5 minutes is X = 1080 m for the Racoviţă athletes and X = 1175 m for those from Steaua. The difference between the two means is X = 95 m in favour of the Steaua athletes. It results thus that the athletes belonging to the Steaua Club covered a longer distance within the 5 minutes as compared to those from Racoviţă.

Standard deviation is S = ± 141.2 m for the Racoviţă athletes and S = ± 112.6 m for those from Steaua. The difference is S = ±28.6 m in favour of the Steaua athletes.

The coefficient of variability (Cv) is 13.07% for the Racoviţă group, which indicates that it has an average homogeneity, an average dispersion. The coefficient of variability (Cv) is 9.58% for the Steaua group, which shows that it has a high homogeneity, a small dispersion. The difference of Cv is 3.49% in favor of those from Steaua, which indicates that the dispersion degree of the results obtained by the Steaua athletes is smaller and the group is homogeneous as compared to the Racovita athletes, who form a relatively homogeneous group (average homogeneity), with a higher dispersion of the obtained results.

In relation to the mean of the maximal aerobic speed (VAM) expressed in test I, this is X = 12.9 km/h for the Racovita athletes and X = 14.1 km/h for the Steaua athletes. The difference is X = 1.2 km/h in favour of those from Steaua. This shows that the Steaua athletes have a higher aerobic effort capacity (endurance) than the Racovita athletes.

- Data analysis and interpretation – test 2 (VAM endurance test – Table 2)

The mean of the covered portions is P = 7 for the Racovita athletes and P = 8/30 sec (portion 8 + 30 sec) for the Steaua athletes. The difference between the two means is P = 1/30 sec (one portion + 30 sec => 1.30 min) in favour of the Steaua athletes, which indicates that they covered more portions than those from Racovita.

Standard deviation is S = ± 1/15 sec (one portion + 15 sec) for the Racovita athletes and S = ± 1 (one portion) for the Steaua athletes. The difference is S = ± 0.15 sec in favour of those from Steaua.

The coefficient of variability is Cv = 17.85% for the Racovita group, which shows that it has an average homogeneity, an average dispersion. The coefficient of variability is Cv = 11.76% for the Steaua group, which indicates that it has an average homogeneity, an average dispersion. The difference is Cv = 6.9% in favour of those from Steaua, which shows that the dispersion degree of the results obtained by these athletes is smaller and the group is more homogeneous as compared to those from Racovita, who form a relatively homogeneous group, with a higher dispersion of the obtained results.

In relation to the mean of the maximal aerobic speed (MAV) expressed in test II, this is X = 11.5 km/h for the Racovita athletes and X = 12.3 km/h for the Steaua athletes. The difference is X = 0.8 km/h in favour of those from Steaua, which shows that their aerobic effort capacity is higher than that registered by the Racovita athletes.

- VAM correlation – test 1 and test 2 (Table 2). In relation to the intensity of the association (Pearson's correlation) between the maximal aerobic speed (VAM) value obtained in the first test and in the second test, r = 0.778 for the Racovita athletes; by comparing the t value = 3.72 with Fisher's table at n - 2, we can establish that r is significant at the p = 0.01 threshold, the connection between these performances having less than 1% chances to be accidental.

For the Steaua athletes, r = 0.884; by comparing the t value = 5.69 with Fisher's table at n - 2, we can establish that r is significant at the p = 0.01 threshold, the connection between these performances having less than 1% chances to be accidental.

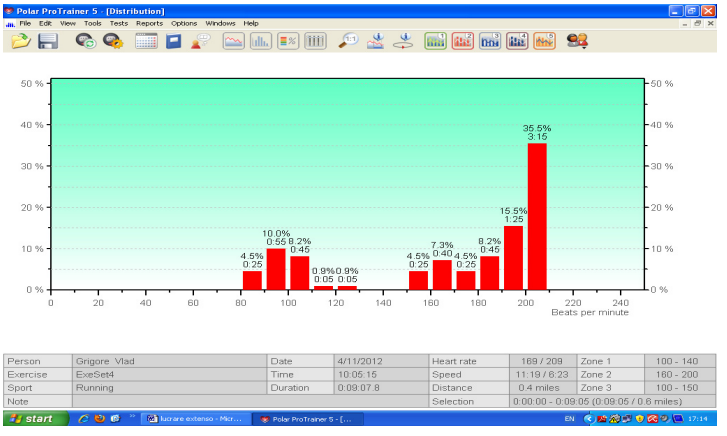
The values of these correlations prove us that the test selection was not accidental and that the VAM values expressed in the two tests are approximately equal.

The heart rate evolution during the two tests is presented in graphs 1 and 3. Its percentile distribution is shown in graphs 2 and 4. From the multitude of obtained graphs, we shall present only a part, as follows:

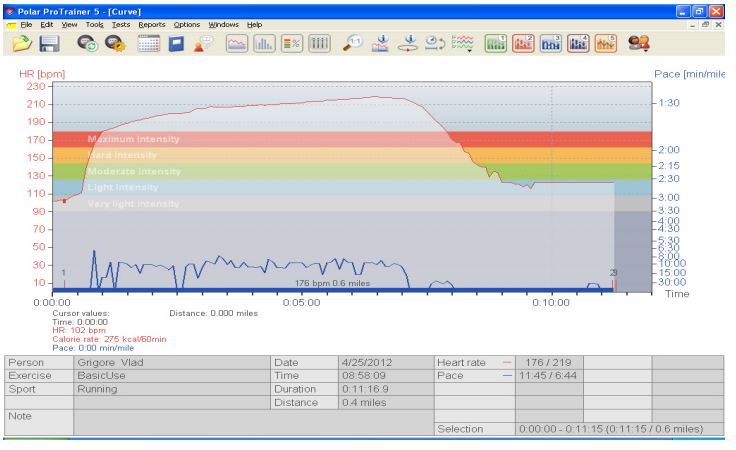
- Test 1. The athlete G.V. (Emil Racoviţă Sports Club) starts with a HR value of 105 bts/min. This one constantly increases up to the value of 209 bts/min, when the effort stops (Graph 1). The HR percentile distribution highlights the following more important values recorded during the testing: HR between 180 and 190 bts/min = 8.2%, between 190 and 200 bts/min = 15.5% and between 200 and 210 bts/min = 35.5%, the remaining percents up to 100% representing the warm-up and the body recovery sequences (Graph 2).

- Test 2 . The athlete G.V. starts with a HR value of 102 bts/min. This one constantly increases up to the value of 219 bts/min, when the effort stops (Graph 3). The HR percentile distribution emphasizes the following more important values recorded during the testing: HR between 180 and 190 bts/min = 6.6%, between 190 and 200 bts/min = 8.1%, between 200 and 210 bts/min = 19.1% and between 210 and 220 bts/min = 27.2%, the remaining percents up to 100% representing the warm-up and the body recovery sequences (Graph 4).

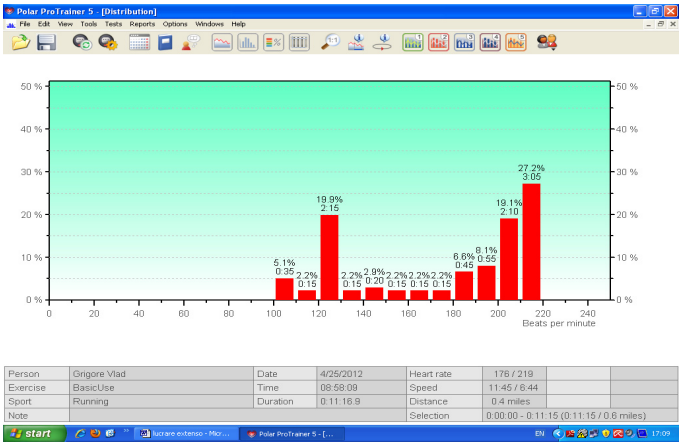
Graph 1. HR evolution in test I, for the athlete G.V.



Graph 2. HR percentile distribution in test I, for the athlete G.V.



Graph 3. HR evolution in test II, for the athlete G.V.



Graph 4. HR percentile distribution in test II, for the athlete G.V.

3. Conclusions

The utilization of the above-mentioned tests (VAM and the 5-minute endurance running test) reveals their role, values and limits in estimating the athletes' effort. Coaches can make a clear distinction between the tests appropriate to the evaluation of their athletes' functional condition and those accessible to them, which allow the effort capacity measurement.

By using the Polar S625X Running Computer for the athletes' testing/evaluation, coaches are provided the following information: metabolic cost, effort distribution on zones, effort dynamics management, covered distances etc., which leads to an objective evaluation of the effort capacity level.

The obtained results in the effort capacity testing through nonspecific means show us that, in the Steaua athletes case, the aerobic effort capacity is higher than that of the Racoviţă athletes. The higher effort capacity on dry land is correlated to a very good performance in the water, too. This finding shows us that by testing the higher aerobic effort capacity on dry land, we can collect information about sports performance in the water environment – *the hypothesis of our research is validated*.

VAM endurance test requires the maximal potential reaching, in relation to the young athletes' heart rate. In 99% of the cases, the VAM value expressed in test I is higher than that expressed in test II.

The lower the heart rate and the longer the duration of intense effort, the greater the effort capacity due to the economy of effort, to functional harmony etc.

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